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ERP training with a web-based electronic learning system: The flow theory perspective

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Abstract

Whilst the importance of end-user training is recognized as a factor in the success of information systems, companies have suffered from relatively low information system training budgets and an insufficient number of trainers. However, technological innovations in computers, telecommunications and the Internet, e-learning has made it possible to overcome many constraints. In this study, we suggest an e-learning success model based on flow theory. A questionnaire-based empirical study was used to test the model. It used data from e-learners who participated in a program on Enterprise Resource Planning training with a web-based e-learning system supported by the Korea Ministry of Information and Communication. Results confirm the significant interdependent relationships between the characteristics of e-learning, flow experience, learners' attitude towards e-learning, and the resulting learning outcomes. In particular, it was revealed that flow experience plays a critical role as a central part of our research model, having direct and indirect impact on learning outcomes (i.e., the technology self-efficacy in ERP system usage in this study). This study should be of relevance to both researchers and practitioners alike, as a step towards a better understanding of e-learning, especially in the context of information system training.

Keywords: E-learning; Flow theory; End-user training; ERP

1. Introduction

There are varieties of reasons that the implementation of an information system in an organization might be disappointing, or indeed actually fail. A significant reason is ineffective or inefficient information system training for the end users who interact with computer systems. These users are usually not systems analysts or programmers, but they need to adequately operate the information system. Effective training can facilitate a positive attitude towards the system, engender user acceptance, and increase skills and knowledge. Training for information systems usage can be the critical component in the success of an information system (Medsker and Medsker, 1987; Nelson and Cheney, 1987; Cronan and Douglas, 1990; Yaverbaum and Nosek, 1992). However, most companies have relatively low information system training budgets and a small number of trainers (Yaverbaum and Nosek, 1992). These constraints, however, are diminishing with the evolution and adoption of web-based e-learning systems.

Because of technological advancements in computers, telecommunication, and multimedia, education environments have evolved. Electronic learning (e-learning), where instruction can be provided from a single host site to multiple distant sites, is possible by taking advantage of synchronous/asynchronous computer-based interactions, local area networks (LANs), wide area networks (WANs), and the Internet. As one of the most significant recent developments in the information system industry, e-learning systems have become a critical issue in both practice and research (Webster and Hackley, 1997;

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Williams et al., 1999; Volery and Lord, 2000; Carswell and Venkatesh, 2002; Wang, 2003).

The potential use of information technology in education and training, shares the very characteristics of information technology that businesses have used to gain competitive advantage and allow a range of productive improvements: the interactivity of computers, the distribution of information, the provision of analytical tools, the elimination of distance barriers, and, to a lesser extent, the replacement of repetitive tasks (Leidner and Jarvenpaa, 1993). Through a series of previous comparative studies on teaching effectiveness, it has been identified that distance education is as effective as traditional on-campus approaches for delivering information (Dohner et al., 1985; Fraser, 1985; Sullivan and Osburn, 1990; Jones and Timpson, 1991; Maloy and Perry, 1991; Threlkeld and Brzoska, 1994; Saba, 2000).

For researchers and practitioners in the field, it would be of use to conduct a post facto theoretical discussion of research results based on a theoretical framework or fundamental concepts and constructs (Saba, 2000). However, absent from most comparative research on information technology, telecommunication, and multimedia in distance education is a discussion of theoretical foundations of the field. Furthermore, subjects in those comparative studies were treated collectively as a group, and constructs related with perceived characteristics of learning methods and other instructional outcomes were ignored or eliminated. Therefore, exploring relationships amongst those constructs is required.

Recently, researchers have initiated studies that explore which factors are relevant to learner satisfaction or education effectiveness in an e-learning environment. Such research efforts have developed instruments for measuring learner satisfaction with asynchronous e-learning systems, or have identified critical success factors in online delivery (see Volery and Lord, 2000; Wang, 2003). There is, however, little research effort for developing a comprehensive theoretical model and verifying it with an empirical study, especially within the context of an interactive e-learning system for information system training.

Thus, our study aims to narrow these gaps. We first introduce *flow theory* in the context of the e-learning domain as a theoretical foundation. This approach can be helpful for better understanding and explaining e-learning and its resulting effects. Second, within the context of information system training, we examine which factors are relevant to the learner's state-specific experience (*flow experience*) and preference (*attitude*) towards a specific e-learning system in explaining learning outcomes. Third, we empirically test the proposed model using survey data collected from an enterprise resource planning (ERP) training program that is supported by the Korea Ministry of Information and Communication (KMIC). This research is specifically related the context of a state-of-the-art e-learning system that is based on network technology for real-time interaction amongst users, instructor, and the e-learning system itself.

In the next section, we review extant literature for e-learning and flow theory, and develop hypotheses regarding the relationships amongst the constructs in our research model. Then, we introduce a case involving ERP training with a web-based e-learning system in Korea followed by discussion of data and the analysis, prior to presenting our results. In the final section, we discuss the implications of our empirical results and outline some directions for future research.

2. Literature review

2.1. What is e-learning?

Before a comprehensive discussion of e-learning can be undertaken, it is necessary to clarify the terms *distance learning* and *e-learning*. Distance learning can be defined as any approach to education delivery that replaces the same-time, same-place, and face-to-face environment of a traditional classroom (Volery and Lord, 2000). More specifically, there are five main elements of distance education: the separation of teacher and learner; the influence of an educational organization; the use of technical media to unite the teacher and learner and to carry educational content; the provision of two-way communication so that the student may benefit from or even initiate dialogue; and the possibility of occasional meetings for both didactic and socialization purposes (Keegan, 1990).

On the other hand, e-learning can be defined as the most recent evolution of distance learning (Raab et al., 2002). In its broadest definition, e-learning includes instruction delivered via all electronic media, including the Internet, intranets, extranets, satellite broadcasts, audio/video tape, interactive TV, and CD-ROM (Govindasamy, 2002). In a more narrow definition, a key element in e-learning (sometimes also defined as "Internet-enabled learning") is the use of network technologies to create, foster, deliver, and facilitate learning, anytime and anywhere (Raab et al., 2002). Thus, in this study, e-learning is defined as the most recent evolution of distance learning that creates, fosters, delivers, and facilitates learning, anytime and anywhere, with the use of interactive network technologies. Table 1 shows the comparison between traditional distance learning and present day distance learning, that is, e-learning.

The literature on e-learning and online delivery in the field of education, has flourished since the early 1990s with the rise of the Internet. The reasons that e-learning has been prevailing in recent years are primarily the convenience, flexibility and adaptability of the mode of education that is strategically aligned to the new paradigm in education. A shift in paradigms from "teaching" to "learning", which aims to achieve learning through any means that results in the best learning, not just through the

Table 1
Evolution of distance learning

	Past	Present
Definition	Any approaches to education delivery that replace the same-time, same-place, and face-to-face environment of a traditional classroom (i.e., *correspondence teaching*; *multi-media distance teaching*)	The most recent evolution of distance learning that creates, fosters, delivers, and facilitates learning, anytime and anywhere, with the use of interactive network technologies (i.e., *e-learning*)
Paradigm in education	Focus on teaching: lesson based Objectivist model of learning in which learners are passive A series of lectures for efficient transfer of knowledge from instructor to learner	Focus on learning: learner based Constructive, collaborative, and cognitive information processing of learning Individual differences in the learning process; learning as a social process
Interaction	Lack of direct interaction between the teacher and the learner Asynchronous interaction	Interactions between instructor and learner, and among learners Asynchronous/synchronous or real-time (e.g., chat forum, instant messaging, video conferencing) interaction
Technology	Written or printed materials, broadcast media, audio/videotapes, telephone, and CAI/ CBT with stand-alone computers	All electronic media, especially, network technologies such as the Internet, intranets, and extranets

traditional series of lectures, has recently occurred in education (Barr and Tagg, 1995). Learning is no longer viewed as an individual process, but a social one in which knowledge and skill are discovered and built via interaction with instructor and other learners. From the perspective of learning theory, this shift in education seems to imply the shift from the objectivist model in which learners are passive, to the constructive model and its derivations (i.e., collaborative and cognitive information processing model) in which the role of the learner is emphasized. This shift in paradigm strategically fits the evolution of distance learning.

There are three generations of distance education (Kaufman, 1989; Nipper, 1989). The first generation was characterized by the use of a single technology; the second generation was characterized by an integrated multiple-media approach and specially designed learning materials for study at a distance. In both generations, however, direct interaction between the learner and the instructor was lacking. In contrast, the third generation is based on two-way communications media that allows for direct interaction between the instructor, who originates the instruction, and the remote learner, which is one of the key characteristics of e-learning. There is clearly a progressive increase in learner control, opportunities for dialogue, and emphasis on thinking skills in the third generation distance education (Kaufman, 1989). These elements reveal that the development of a new paradigm in education coincides with the evolution in distance learning. In times past, distance learning supported the objectivist model of knowledge transmission. The knowledge was simply transmitted to learners at different locations. Being equipped with facilities to enable learners to communicate with each other, however, distance learning can also promote collaborative learning across distances (Leidner and Jarvenpaa, 1993).

From the view point of technology, the evolution of distance learning ranges from passive and asynchronous distance learning using written or printed material, audio, videotapes, telephone, and computer-assisted instruction (CAI) computer-based training (CBT) with stand-alone computers to active and synchronous distance learning by using two-way interactive technology with the use of the Internet and the World Wide Web. E-learning goes beyond computer-based learning (e.g., CAI and CBT) in the second generation of distance education in which computers are not necessarily linked to a network, as e-learning makes full use of the Internet and other digital technologies. It may include the provision of student access to learning resources, the facilitation of communication and collaborative work amongst and between students and academic staff via network communication technologies such as a chat forum, instant messaging, and video conferencing, the assessment of individual students or a group of students, and the provision of administrative and student support.

In the early stage, however, e-learning was not always successful. Threlkeld and Brzoska (1994) state that in distance learning, maturity, high motivation levels, and self-discipline have been shown to be necessary characteristics of successful and satisfied students. Furthermore, Kirkup and Jones (1996) summarize the most significant weaknesses of distance education as (a) its inability to offer dialogue in the way that conventional face-to-face education does; (b) the inflexibility of its content and study method; and (c) the isolation and individualization of the student. However, these kinds of limitations are diminishing due to the evolution of two-way interactive technology and the Internet.

2.2. Prior research on distance learning

Prior research on distance learning can be divided into two categories: one group of studies is a series of comparison studies to reveal which of the education delivery modes, distance learning and education in traditional way, is more effective. The other group of studies, initiated in recent years, is focused on which factors are salient for learner satisfaction, or deemed to be successful for a specified e-learning system (generally based on Internet and/or web technology).

Since the 1950s and expansion of social research, distance education has been studied in comparison to face-to-face or classroom instruction. Although researchers continue to conduct comparative studies, their usefulness in revealing more information has diminished over the years; invariably, they have returned a "no significant difference" result between various forms of instruction (Dohner et al., 1985; Fraser, 1985; Sullivan and Osburn, 1990; Jones and Timpson, 1991; Maloy and Perry, 1991; Saba, 2000). Haynes and Dillon (1992) compared traditional learning and two-way video conferencing on instructional tasks found no significant differences in learning gains. Wetzel et al. (1994) have summarized the results of studies until the mid-1990s and showed that comparative studies of distance education and classroom instruction show "no statistically significant difference." More recently, Smith et al. (2000) compared online instruction as an alternative to three modes of traditional instruction in special education (lecture, guided instruction, and collaborative discussion), and found that there were no significant differences between them. Johnson et al. (2000) compared learning outcomes of an online course with a similar course taught face-to-face and concluded that there was no difference between the two course formats in several measures of learning outcomes. Furthermore, in recent meta-analysis of 19 studies out of an original pool of 700, Machtmes and Asher (2000) confirmed previous conclusions that there does not appear to be a significant difference between distance and traditional learners in achievement goals.

In recent years, researchers have initiated studies that explore which factors are relevant to learner satisfaction or education effectiveness in the e-learning environment. Webster and Hackley (1997) drew an initial conceptualization of influences on technology-mediated distance learning outcomes from research in management communications, education, and information systems (e.g., reliability and quality of the technology, instructor's attitudes, teaching style, and control over the technology) and reported on an exploratory study to examine students' reactions to such distance learning. Volery and Lord (2000) conducted a survey amongst students enrolled in one online management course at an Australian university, and identified critical success factors in online delivery (i.e., characteristics of technology, the instructor, and the previous use of the technology from a student's perspective). Wang (2003) developed an instrument for measuring learner satisfaction with asynchronous e-learning systems (i.e., learner interface, learning community, content, and personalization). There are few studies suggesting a comprehensive theoretical model in the context of the e-learning system for information system training. Research that suggests and empirically validates a theoretical conceptual model with a state-of-the-art e-learning system is clearly required.

2.3. Theoretical background

Our research model, presented in Section 3, centers on the construct of flow experience and attitude towards e-learning. They are the central constructs in the research streams of flow theory and theory of reasoned action (TRA), respectively. Therefore, it may be helpful to introduce those theories as the potential theoretical foundation.

2.3.1. Flow theory

The original concept of *flow* is defined as the *holistic sensation* that people feel when they act with total involvement (Csikszentmihalyi and LeFevre, 1989; Csikszentmihalyi, 1990). The state of flow occurs when an individual is partaking in an activity for its own sake; the state is so satisfying that individuals want to repeat the activity continually (Csikszentmihalyi, 1988). Csikszentmihalyi summarized the most commonly exhibited factors of flow into nine characteristic dimensions, including clear goals, immediate feedback, potential control, the merger of action and awareness, personal skills well suited to given challenges, concentration, loss of self-consciousness, time distortion, and autotelic experience (Csikszentmihalyi, 1975, 1988, 1990, 1993). Such a concept has been extensively applied in studies of a broad range of contexts, such as sports, work, shopping, rock climbing, dancing, games, and others (Csikszentmihalyi and LeFevre, 1989).

In the last few years, flow theory has been borrowed from psychology to address positive user experiences in various disciplines, including consumer behavior, communications, human–computer interaction, and management information systems (Finneran and Zhang, 2003). As an alternative stream of research, flow theory posits that individual behavior towards new information technologies is shaped by *holistic experiences* with the technology (Agarwal and Karahanna, 2000). The flow construct has been recommended as a possible metric of user experience in the context of information systems and computer-mediated environments (see Ghani, 1991; Ghani et al., 1991; Trevino and Webster, 1992; Webster et al., 1993; Ghani and Deshpande, 1994; Hoffman and Novak, 1996; Chen et al., 1999; Agarwal and Karahanna, 2000; Novak et al., 2000; Koufaris, 2002; Woszczynski et al., 2002; Finneran and Zhang, 2003). Within this context, the experience of flow has been shown to lead to increased exploratory behavior, communication, positive affect, satisfaction and acceptance of information technology,

computer use, learning, and training (Woszczynski et al., 2002; Finneran and Zhang, 2003). Especially, some previous studies have argued that there is a link between flow and learning (Csikszentmihalyi and LeFevre, 1989; Ghani et al., 1991; Webster et al., 1993; Hoffman and Novak, 1996).

The construct of flow is, however, too broad and ill-defined due to the numerous ways it has been operationalized, tested, and applied (Koufaris, 2002; Finneran and Zhang, 2003; Finneran and Zhang, 2005). For example, flow is treated as an uni-dimensional central component in some studies (e.g., Hoffman and Novak, 1996; Novak et al., 2000), and as a multi-dimensional construct in others (e.g., Webster et al., 1993; Ghani and Deshpande, 1994). Finneran and Zhang (2003) pointed out that the ambiguities in the conceptualization of flow constructs and inconsistency in the flow model stem from the direct adoption of the traditional flow theory without a careful re-conceptualization considering the unique context in computer-mediated environments. For empirical flow studies in computer-mediated environments, a framework of three stages including flow antecedents, flow experience, and flow consequences is generally agreed upon (Ghani, 1991; Trevino and Webster, 1992; Ghani and Deshpande, 1994; Chen et al., 1999; Finneran and Zhang, 2003). Focusing on the flow antecedents, Finneran and Zhang (2003) proposed a component-based model that consists of person, artefact, and task, as well as the interaction of these components. Within the model, activity is broken down into the task (main goal of the activity) and the artefact (tool for accomplishing the activity) under the complex and dynamic nature of the artefacts in computer-mediated environments. In this study, we consider taking the ERP training course with an e-learning system as an activity using education-oriented web-based technology of which flow experience can be used as a possible valid metric as a holistic experience where an individual engages with total involvement. Thus, we see value in their approach as a logical foundation to develop the research model and hypotheses, identifying which antecedents can contribute to the flow experience in the e-learning environment.

2.3.2. Theory of reasoned action

The theory of reasoned action is perhaps one of the most influential efforts to generate and test a general theory of attitude–behavior links. The theory begins with the assumption that an individual behaves in accordance with his or her conscious intention, which are based in turn on rational calculations about the potential effects of the behavior. In other words, belief that is an individual's subjective probability of the consequence of a particular behavior, influences attitude, which in turn shapes behavioral intention (Ajzen and Fishbein, 1980). TRA appeals to many social psychologists because it makes people seem rational and it places attitude in a central place.

Attitude is a person's consistently favorable or unfavorable evaluation, feeling, and tendency towards an object, behavior, or idea. In TRA, only the evaluative component of attitude is considered (Bajaj and Nidumolu, 1998). Thus, a person will have a more positive attitude towards performing an action if he or she believes it will have major consequences and that these will be good. External stimuli are believed to influence attitude only through a change in the person's belief structure. In an e-learning environment, the attitude construct could be a general attitude about e-learning or an attitude towards a specific e-learning system. In the context of our study, we focus on the latter, that is, ERP training with a specific web-based e-learning system. Thus, in our model, attitude towards e-learning represents a student's evaluative feelings about using the specific e-learning system for ERP training.

According to TRA, a student's attitude towards using the e-learning system for ERP training would shape his/her behavioral intention from which actual behavior, that is, mastering how to use ERP system can be predicted. From our model, we leave out behavioral intention for the following reasons. First, as Taylor et al. (1997) pointed out, behavioral intention is not very different from attitude towards the behavior. It is sometimes difficult to obtain measures of behavioral intention that are truly independent of attitude towards the behavior and actual behavior (Taylor et al., 1997). Second, a phenomenon of interest in our model is the post-training outcomes—whether the students have mastered the ERP training course rather than whether they intend to use the e-learning system later. In the context of our study, the specific e-learning system itself is considered as an artefact with which students develop their ability to use the ERP system. Hence, although much prior literature focused on intention to use as a surrogate measure for information system success, it can be reasonable to consider learning outcomes as a resulting dependent variable in an e-learning context.

With regard to learning outcomes, although the objective measure of student performance represents a key aspect of learning outcomes, it is sometimes difficult to access to student grades due to privacy. In addition, it is recommended to move beyond the limited perspective of the grade point as an indicator of student learning (Cleveland and Bailey, 1994; Webster and Hackley, 1997). Especially, in the context of information system training, it is very important to evaluate students' confidence of their capabilities to employ the information technology appropriately (Chou and Liu, 2005). Moreover, research has shown that the self-efficacy has an important impact on performance (Martocchio and Webster, 1992). Thus, post-training self-efficacy has been considered as a measure of learning outcomes in the context of information system training (Martocchio and Webster, 1992; Chou and Liu, 2005). Based on Bandura's (1986) definition, self-efficacy refers to people's judgments of their capabilities to attain designated types of performance. The construct coincides with the main purpose of the ERP training course, that is, mastering how to use ERP systems to perform tasks. Thus, in this study, we define technology

self-efficacy as a student's self-perceived ability to use the ERP system after the training course and use it as a surrogate for learning outcomes in ERP training.

Whilst TRA and flow theory may seem too discrete to combine in one study, we believe that they can complement each other successfully to form a hybrid theoretical perspective. By reviewing TRA and flow studies, we can see that flow is focused more on the *affective/holistic* experience, whereas TRA is more *rational/analytical*. TRA is a model that is concerned with the determinants of *consciously* intended behaviors (Ajzen and Fishbein, 1980). In TRA, individuals are assumed to be usually quite *rational* and make systematic use of information available to them. People consider the implications of their actions before they decide to engage or not engage in a given behavior. Attitude is determined by the individual's subjective probability of the consequence of a particular behavior, weighted by his/her evaluation of those consequences in the theory (Ajzen and Fishbein, 1980). Flow, on the other hand, is the *holistic* sensation that people feel when they are so involved in an activity that nothing else seems to matter and it is characterized by loss of self-consciousness, time distortion, and autotelic experience (Csikszentmihalyi, 1990). Thus, the riveting and engaging experience can cause not only positive outcomes but also negative outcomes such as over-involvement and addiction to the Internet or to video games (Agarwal and Karahanna, 2000; Woszczynski et al., 2002).

Despite differences between those two theories regarding the specific constructs (i.e., attitude and flow experience) and notions focused on (i.e., rational/analytical and affective/holistic, respectively), there is some convergence amongst them—the characteristics of a specific object or activity have a significant influence on an individual's behavior. More specifically, in TRA, a student's evaluation about or perceptions of the ERP training with an e-learning system determine attitude towards using the specific e-learning system for ERP training, which in turn influences his/her behavior of mastering how to use the ERP system. Similarly, in flow theory, the characteristics of the e-learning environment contribute to a student's flow experience, which in turn leads to his/her learning, that is, mastering how to use the ERP system. Thus, incorporating student's attitude and flow experience, each of which makes up the central point in the corresponding theories, can provide a useful and reliable theoretical background for the e-learning environment.

3. Research model and hypotheses

The constructs and hypothesized links in our model are shown in Fig. 1. It asserts that a learner's flow experience and attitude towards e-learning mediate the impact of the relevant factors of the e-learning course on learning outcomes. Flow experience is defined as a holistic experience of total involvement and intrinsic interests with which an individual engages in the ERP training courses. Attitude towards e-learning is influenced by his/her evaluation on the ERP training course with a web-based e-learning system. The model indicates that flow experience also affects attitude towards e-learning. We also proposed that flow experience and attitude towards e-learning affect learning outcomes. We present theoretical arguments below supporting the proposed paths, and subsequently present data from a cross-sectional study in support of these relationships.

3.1. Key antecedents of flow experience and attitude in e-learning

The identification of relevant factors in the e-learning environment is receiving increased attention in the information

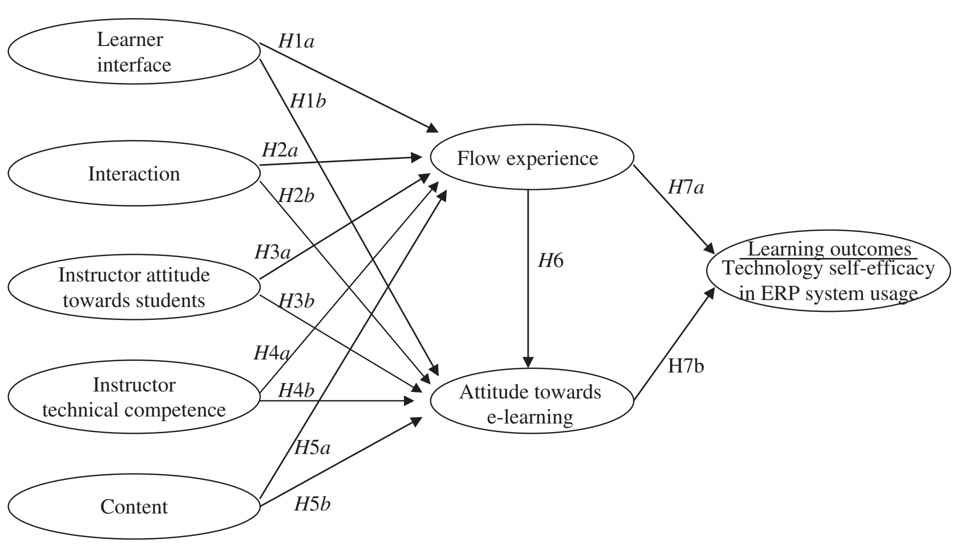

Fig. 1. The research model.

system research community. According to studies conducted by Webster and Hackley (1997), Dillon and Gunawadena (1995), and Leidner and Jarvenpaa (1993), three main characteristics (i.e., technology, instructor, and student characteristics) influence the effectiveness of online delivery. Volery and Lord (2000) emphasized that it is essential to understand the critical factors affecting the online delivery of education, and identified critical success factors in online delivery (e.g., interface, interaction, instructor attitudes towards students, and instructor technical competence). Wang (2003) also argued that current models for measuring user satisfaction and learners' evaluation of teaching effectiveness are inapplicable to the e-learning environment because they are targeted primarily towards either organizational information systems or a classroom education environment. Thus, an instrument was developed for measuring learner satisfaction with e-learning systems (e.g., learner interface and content). For the practical utility of our model, we focus on the antecedents over which system designers or managers have some degree of control. To the extent that they are key determinants of dependent variables, they provide direction to designers or managers as to where efforts and resources should be focused. Although past research has suggested the importance of individual factors in flow study and e-learning domain, student characteristics are not manageable factors. Hence, we leave out individual factors in this study. Next, we present hypotheses for incorporating key antecedents with flow experience and attitude in the e-learning environment.

3.1.1. Learner interface

Easy to use learner interface is a critical component, because learners who are not comfortable with the use of technology are apt to spend a large amount of time learning to interact with the technology and therefore have less time to focus on the lesson (Hillman et al., 1994; Trevitt, 1995). Volery and Lord (2000) emphasized the importance of the ease with which the students can access the site and the usability of the software in general. Wang (2003) also presented the easy to use learner interface as a critical evaluative factor for an e-learning system, and operationalized it with items focusing on the learner's perception on the ease of use of the e-learning system. When a person perceives his/her skills of doing an activity to be less than needed to meet the given challenges, he or she feels anxiety (Csikszentmihalyi, 1975). A person with high perceived ease of use of the artefact is more likely to experience flow (Finneran and Zhang, 2003). In an e-learning context, a learner's perception of an easy to use learner interface represents a linkage between person and artefact that serves as the person–artefact interaction. Empirical work has also shown that perceived ease of use influences flow (Trevino and Webster, 1992). In addition, several studies have found that the perceived ease of use of a system is linked to the user's attitude towards using the system (Davis et al., 1989; Bajaj and Nidumolu, 1998).

Accordingly, the following hypotheses were proposed:

Hypothesis 1a. Easy to use learner interface is positively related to flow experience.

Hypothesis 1b. Easy to use learner interface is positively related to positive attitude towards e-learning.

3.1.2. Interaction

Interaction involves the interactive abilities of an e-learning system amongst all students and the instructor, and direct/timely feedback from the system (Volery and Lord, 2000). One of the most common problems of distance education is the limitation of communication between teacher and learners, and amongst learners themselves (Kirkup and Jones, 1996; Chen, 1997). Thus, the concept of interaction is a common theme in distance education research (Saba, 2000). Indeed, McIntyre and Wolff (1998) noted that one of the powers of interactivity in a web environment is the capability to engage by providing rapid, compelling interaction and feedback to students. Fulford and Zhang (1993) studied learner perception of interaction in instruction and concluded that perception of the level of interaction is a critical predictor of learner satisfaction. Palloff and Pratt (1999) also emphasized that the key to the learning process involves the interactions amongst students themselves, the interactions between faculty and students, and the collaboration in learning that results from these interactions. The interaction dimension indicates that the school must not attempt to come to terms with the Internet in a fetish way, i.e., to require their lecturers to merely put their lecture notes on the Web. The result of that approach is too well-known: lectures become even more rigid and boring (Volery and Lord, 2000). Further, the interaction factor encompasses feedback from the e-learning system. In computer-mediated environments, feedback that is emphasized as an important dimension of flow (Csikszentmihalyi, 1988) is typically referred to as interactivity (Finneran and Zhang, 2003). Though some researchers (e.g., Hoffman and Novak, 1996) distinguished between person interactivity and machine interactivity, the distinction between them is not always as clear-cut for tasks within computer-mediated environments (Finneran and Zhang, 2003). This viewpoint is in accordance with Volery and Lord's (2000) interaction factor. The feedback on e-learning can be from a person (i.e., the instructor and other students) or a machine (i.e., the e-learning system itself). Considering feedback on the task as the person–task interaction, Finneran and Zhang (2003) also proposed the link between adequate feedback on the task and flow experience. Thus, one of the most salient requirements for e-learning can be the use of technology to allow interaction between the instructor and students and amongst individual students for direct and timely feedback. In addition, studies in distance learning have shown that student attitudes toward distance education can be significantly affected by facilitating some degree of interaction amongst students and

teachers (Hult, 1980; Ritchie and Newby, 1989). The ability to interact strongly influences students' attitude, therefore, the ways of interaction should be structured in distance learning situations (Sun and Hsu, 2005).

Accordingly, the following hypotheses were proposed:

Hypothesis 2a. More interaction is positively related to flow experience.

Hypothesis 2b. More interaction is positively related to positive attitude towards e-learning.

With regard to instructor characteristics, Collis (1995, p. 146) remarked that the instructor plays a central role in the effectiveness of online delivery: "It is not the technology but the instructional implementation of the technology that determines the effectiveness of learning." Webster and Hackley (1997) suggested that instructor competence that includes teaching style and control of the technology influence learning outcomes in technology-mediated distance learning. Volery and Lord (2000) also presented instructor attitude towards students and technical competence as critical success factors in online education.

3.1.3. Instructor attitude towards students

An instructor's attitude towards students relates to the instructor's personal approach, teaching style, and their advice/help in class and through the Internet (Volery and Lord, 2000). The teaching style of an instructor is even more important in technology-mediated distance learning (Webster and Hackley, 1997). In a distributed learning environment, students often feel isolated since they do not have the classroom environment in which to interact with the instructor (Serwatka, 1999). To overcome this feeling, instructors should exhibit interactive teaching styles with advice and help, encouraging interaction between the students and the instructor. With the advice and help from instructors, learners may have more chance to recognize clear goals and get immediate feedback, which are conducive to flow experience. Further, more interactive teaching styles have a significant positive relationship not only with students' cognitive engagement but also with their attitude towards using a specific technology for distance learning (Webster and Hackley, 1997).

Accordingly, the following hypotheses were proposed:

Hypothesis 3a. Instructor attitude towards students is positively related to flow experience.

Hypothesis 3b. Instructor attitude towards students is positively related to students' positive attitude towards e-learning.

3.1.4. Instructor technical competence

Instructor technical competence relates to the instructor's ability to use and promote the related technology effectively (Volery and Lord, 2000). It is crucial for the instructor to have good control of the technology and to be able to perform basic troubleshooting tasks, since students in the e-learning courses often face technical problems. Otherwise, learners may view the instructor with little control over the technology as being less competent overall (Webster and Hackley, 1997), and become impatient (Leidner and Jarvenpaa, 1993). With technical competence, the instructor can give learners adequate feedback in every possible way such as handling the instant messaging system and e-mail queries rapidly and/or solving emerging technical problems efficiently in a remote fashion. In addition, instructor technical competence suggests that the instructor is not only the repository of knowledge but s/he can play an important role as a knowledge navigator (Volery and Lord, 2000). As a knowledge navigator, the instructor can provide learners with clear goals and required technical skill for e-learning by guiding them on how to handle the e-learning systems and/or, in the case of information system training, how to use the related system package. Within technology-mediated distance learning, the instructor's control of technology was shown to have a positive relationship with students' attitude towards using a specific technology for distance learning as well as with cognitive engagement (Webster and Hackley, 1997).

Accordingly, the following hypotheses were proposed:

Hypothesis 4a. Instructor technical competence is positively related to flow experience.

Hypothesis 4b. Instructor technical competence is positively related to positive attitude towards e-learning.

3.1.5. Content

In an end-user computing environment, content has been considered as relevant for satisfaction (Doll and Torkzadeh, 1988). Also, in e-learning, more essential for learner motivation can be *what* to deliver than *how* to deliver it. Leidner and Jarvenpaa (1993), in their case studies on computer aided instruction, suggested that course content as well as the technology and instructor factors influences the type of teaching method. Further, Wang (2003) argued that content is one of the factors that impacts learner satisfaction with e-learning systems, and he developed an instrument for content mainly focusing on perceived usefulness. Whilst flow studies in the computer-mediated environment focus on artefact, traditional flow studies centered on the interaction between the person and the task of the activity (Finneran and Zhang, 2003). In an e-learning environment, the content to learn corresponds to the task for a student to do, whereas the e-learning system corresponds to the artefact or tool for accomplishing the task. Thus, a learner's perception of content serves as the person–task interaction in the person–artefact–task model. For example, the content of the Web pages which represents the challenge, contributes to flow experience (Skadberg and Kimmel, 2004). In terms of what to learn, content also provides clear task goals for learners. With content that is useful and fits to individual needs, learners may not be confused about what to learn. Further, if a student considers the content provided by the e-learning

system as useful for mastering the course, this belief will lead to his/her positive feeling about using the system.

Accordingly, the following hypotheses were proposed:

Hypothesis 5a. Useful content is positively related to flow experience.

Hypothesis 5b. Useful content is positively related to positive attitude towards e-learning.

3.2. Consequences of flow experience and attitude in e-learning

In an e-learning situation, a specific e-learning system is used for the purpose of education, thus the flow experience with the system can be evaluated rationally desirable as well as satisfying in itself. Previous studies have proposed the link from flow to positive subjective experience or attitude (Trevino and Webster, 1992; Webster et al., 1993; Hoffman and Novak, 1996; Woszczynski et al., 2002). Some researchers (Webster et al., 1993; Hoffman and Novak, 1996) noted that computer-mediated environments that are conducive to flow yield positive subjective experiences for users. Trevino and Webster (1992) suggested that the notion of flow is an important element of understanding human–technology interactions, and indeed, an important antecedent of attitude towards technologies. In technology-mediated distance learning (Webster and Hackley, 1997), there is a significant positive correlation between cognitive engagement and attitude towards using a specific technology for distance learning. Woszczynski et al. (2002) also proposed that the attitude that users form towards interactions with specific technology products is partially a result of the flow state that the user experiences.

Accordingly, the following hypothesis was proposed:

Hypothesis 6. Flow experience is positively related to positive attitude towards e-learning.

The experience of flow has various positive outcomes including learning (Woszczynski et al., 2002; Finneran and Zhang, 2003). Previous research has shown that the experience of flow leads to increased learning (Csikszentmihalyi and LeFevre, 1989; Ghani, 1991; Webster et al., 1993; Hoffman and Novak, 1996; Skadberg and Kimmel, 2004). Webster et al. (1990) found that labeling computer training as play positively affects the training outcome. Within the context of computer interaction, Woszczynski et al. (2002) also theorized that the flow state leads to improved computer proficiency (learning). With regard to student attitude, the approach of considering the construct as a mediator of learning was suggested in the context of a multimedia environment and web-based instruction (Kettanurak et al., 2001; Sun and Hsu, 2005). A student with a negative attitude tends to have a self-fulfilling prophecy of an unsuccessful educational experience when participating in on-line courses (Hiltz, 1993). In addition, student preference for one teaching method over another appears to be an important variable in terms of the method and its effect (Leidner and Jarvenpaa, 1993). The purpose of the e-learning system under investigation in this research is to foster each student's ability to use the ERP system. Thus, in this study, learning outcomes were assessed with the construct of technology self-efficacy which was labeled as distance learning outcomes or software training outcomes in other studies (e.g., Martocchio and Webster, 1992; Webster and Hackley, 1997).

Accordingly, the following hypotheses were proposed:

Hypothesis 7a. Flow experience is positively related to learning outcomes (technology self-efficacy in ERP system usage).

Hypothesis 7b. Positive attitude towards e-learning is positively related to learning outcomes (technology self-efficacy in ERP system usage).

4. Method

4.1. IT training and the web-based e-learning system: a case involving ERP training in Korea

Under the pressure to proactively deal with the radically changing external environment, many firms have changed their information system strategies by adopting application software packages rather than in-house development. An application package such as an ERP system is one solution that automates the flow of material, information, and financial resources amongst all functions within an enterprise on a common database. Although a number of benefits from information systems such as ERP can be gained by most organizations, small and medium-sized enterprises (SMEs) have found difficulties in developing and maintaining information systems due to a lack of human and financial resources. The Korea government attempted to foster the adoption and application of ERP for SMEs that had limited access to information technologies.

It is critical in gaining successful information system implementation not only to adopt the appropriate system but also to give proper training to end-users. Cronan and Douglas (1990) explored the effectiveness of end-user computing following a training program, and found that it increased productivity and resulted in a high degree of satisfaction with the program. Nelson and Cheney (1987) also studied computer training methods and presented significant findings that correlated training with computer-use ability. Recognizing the importance of information systems training, the Korea Ministry of Information and Communication (KMIC) supported ERP training for vocational high school students who are potential employees for SMEs. The KMIC funded the project of online ERP training, which was conducted by the consortium consisting of several public institutes, ERP vendors, and private education institutes. From 2002 to 2004, more than 4500

students in 88 vocational high schools took the ERP training course using a web-based e-learning system.

For more discussion of the ERP training course, in this study, we need to understand the meaning of training more clearly. Though training and education both imply formal transfer of knowledge, there are some differences between them: education involves understanding abstract theory while training involves the accretion of skills necessary to perform a task (Nelson and Cheney, 1987). Training also emphasizes concrete experience and active experimentation rather than abstract conceptualization and reflective observation (Yaverbaum and Nosek, 1992). In addition, training is about learning that is, in turn, about changes in an individual's cognitive and behavioral repertoire (Kraiger et al., 1993). In other words, learning can be treated as the outcome of training, to which the design of the training is linked. Thus, we can consider training as a formal transfer of knowledge via concrete experience and active experimentation, in which an individual learns skills necessary to perform a task. For the case involving ERP training, the coursework was focused on the increase of technology self-efficacy necessary to perform tasks using ERP systems rather than understanding abstract theory or reviewing cases with the objective of reflecting upon issues.

With that primary goal, the ERP training was performed using a web-based e-learning system that provides learners real-time interaction with instructors and other learners. Schools participating in the project were required to have the following: a computer laboratory equipped with more than 35 Pentium PCs, T1 class network access for running an ERP module and interacting with instructor and other students, and a beam projector for displaying class material and showing the instructor's demonstration of how to use the ERP module. Because the ERP module was provided by an application service provider (ASP), it was not required for the participating schools to own and maintain their own ERP system packages. For the ERP training course, both synchronous and asynchronous learning approaches were used. Enrolled students were required to attend 36 h of online ERP classes, which consisted of "lecture–demonstration–individual practice" methods, over a 15-week period. With a synchronous learning approach, the instructor's appearance, voice, and demonstration were transmitted from the studio located in Seoul to the corresponding students' PCs, equipped in each computer laboratory of the participating schools located nationwide via the Internet. Students view two screens: one at the front of computer laboratory that displays class material and the instructor's demonstration, and the other at individual PC monitors that display the window for real time communication with the instructor and other students and the window for practicing the ERP module provided by the ASP vendor. After lecturing on the class material, the instructor demonstrates how to use the ERP module with example tasks. Following the instructor's guidance, each student deals with the example tasks step by step individually. For any support or additional explanation, students can interact with the instructor or other students via the "chatting window" in real time. On the other hand, as an asynchronous approach, a lecture on demand (LOD) was also provided for additional study or review on prior lessons using the Internet. In addition, a bulletin board system for the learning community was also used for exchanging questions and answers between the instructor and other students. Within this asynchronous approach, students can access the resources of the coursework at their own convenience. Deciding how much more knowledge on a topic s/he needs, the individual student can study additionally according to his/her own pace.

4.2. Data collection

We conducted a mail survey targeting the e-learners who had enrolled in the ERP training course in the fall semester, 2004. We contacted all 24 vocational schools that had participated in the ERP training program in the semester (5 of them, 20.8%, are located in Seoul, the capital of Korea, and the rest are located in other regions). Empirical data gathering was performed through an anonymous questionnaire from February to March 2005. The survey was conducted with the help of the guidance teacher in each school who engaged in the training courses. We sent the questionnaires to the guidance teachers and received them back by home delivery services. Three weeks after sending the questionnaires, we called for the teachers to request, once again, that the students complete the questionnaires. The total number of replies received was 236 questionnaires (of 960 distributed). After careful review, 223 valid respondents were retained by eliminating 13 due to extensive empty data fields.

4.3. Measurement

The measurement of the variables was developed from previous studies on distance learning or e-learning: the list of the items is shown in Appendix A. Students indicated their level of agreement or disagreement to each statement along a five-point Likert-type scale. The scale items for learner interface, interaction, instructor attitude towards students, instructor technical competence, and content were developed from the study of Volery and Lord (2000) and Wang (2003). The scales were modified to suit the context of ERP training with a web-based e-learning system in this study. To develop a scale for measuring attitude towards e-learning, we used three items from Taylor and Todd (1995) with modifications. With regard to flow, there are various approaches for measuring flow as addressed in Finneran and Zhang (2005). In this study, we adapted Novak et al. (2000)'s measure of flow experience because we focus on each student's holistic sensation. For technology self-efficacy in ERP system usage, we adapted the items from Hollenbeck and Brief's (1987) perceptions of task-specific ability measure to suit the context of this study, which was adapted and labeled as software efficacy

Table 2
Descriptive statistics and pairwise construct correlations

Variables	LI	IT	IA	TC	CT	FE	AE	LO
Learner interface (LI)	1.000							
Interaction (IT)	0.380***	1.000						
Instructor attitude (IA)	0.127*	0.223***	1.000					
Instructor technical competence (TC)	0.262***	0.251***	0.163***	1.000				
Content (CT)	0.469***	0.301***	0.176***	0.157***	1.000			
Flow experience (FE)	0.593***	0.503***	0.257***	0.188***	0.581***	1.000		
Attitude towards e-learning (AE)	0.573***	0.379***	0.266***	0.315***	0.574***	0.630***	1.000	
Learning outcomes (LO)	0.580***	0.360***	0.220***	0.413***	0.385***	0.537***	0.518***	1.000
Mean	3.30	3.74	3.76	3.45	3.51	3.27	3.55	3.19
Standard deviation	0.84	0.81	0.75	0.76	0.67	0.87	0.71	0.80
Min	1.33	1.00	1.67	1.33	1.00	1.00	1.33	1.00
Max	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

or technology self-efficacy in past research (e.g., Martocchio and Webster, 1992; Webster and Hackley, 1997).

Pre-testing and pilot testing of the measures were conducted to validate the instrument. The pre-test involved four experts in this area, two vocational school teachers, and 10 students who had taken the ERP training course. They were asked to comment on the length of the instrument, the wording of the questions, and any ambiguity or difficulties with the questionnaire. After a pilot test that involved the students who had participated in the training course in the prior semester, the survey with the final instrument involving 24 items was conducted. Conceptual definition, items, and sources for each construct with descriptive statistics are shown in Appendix B, and a correlation matrix of measurement items is shown in Appendix C.

Means, standard deviations, and correlation among latent variables are reported in Table 2. To estimate these descriptive statistics, multiple-item scales were summed and averaged. The correlations between latent variables are computed using LISREL.

4.4. Measurement model

The measurement model fit was assessed by confirmatory factor analysis with LISREL 8.54. Eight common model-fit measures were used to estimate the measurement model fit; χ^2/degree of freedom, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), non-normed fit index (NNFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), root mean square residual (RMSR), and standardized root mean square residual (SRMSR). All the model-fit indexes except GFI exceed their respective common acceptance levels suggested by the prior literature (Chau, 1997; Hair et al., 1998). GFI is also close to the recommended cut-off value 0.90. Therefore, it may be concluded that the measurement model has good fit with the data gathered ($\chi^2/\text{df} = 398.39/224 = 1.779$, GFI = 0.870, AGFI = 0.826, NNFI = 0.970, CFI = 0.976, RMSEA = 0.059, RMSR = 0.330, and SRMSR = 0.045).

4.5. Reliability and validity of the measures

The reliability of measurement items was assessed by the internal consistency method. Cronbach's alpha is generally considered as providing a reasonable estimate of internal consistency. These values range from 0.858 to 0.920; the values all surpass the recommended value of 0.70 or 0.60 (Nunnally, 1978; Hair et al., 1998). The details of this reliability test are shown in Table 3.

Convergent and discriminant validity were assessed for construct validity testing. The convergent validity of the research instruments is commonly estimated by assessing item reliability and average variance extracted (Fornell and Larcker, 1981). All item reliabilities are higher than the 0.50 cut off value. Average variance extracted well surpass the recommended 0.50 value (Fornell and Larcker, 1981; Chau, 1997). It is noted that the measures support convergent validity.

Discriminant validity can be assessed by performing a pair-wise χ^2 difference test (Anderson et al., 1987; Chau, 1997). Significant difference of the χ^2 value between the constrained and unconstrained model indicates a high discriminant validity. The χ^2 value difference ranges from 280.33 (content and attitude towards e-learning) to 408.67 (learner interface and interaction). The discriminant validity test results suggest that the measurement scales are acceptable for discriminant validity. The details are shown in Table 4.

5. Results

Tests of the structural model were performed with (Maximum Likelihood Estimation) MLE and the covariance matrix. LISREL 8.54 and SPSS 10 are used for data analysis. As summarized in Table 5, all the fit indexes exceed recommended cut-off values, except for GFI (0.861) that is slightly lower than recommended threshold value 0.90. Therefore, the research model exhibited quite a good fit with data gathered, as suggested by the inspected GFIs exceeding or corresponding their

Table 3
Reliability and convergent validity test

Construct	Variable	Factor loading	t-value	Item reliability	Cronbach' α	Construct reliability	Average variance extracted
Learner interface	LI1	0.852	15.337	0.724	0.903	0.903	0.757
	LI2	0.895	16.604	0.803			
	LI3	0.862	15.672	0.743			
Interaction	IT1	0.931	17.831	0.867	0.909	0.918	0.789
	IT2	0.906	17.042	0.821			
	IT3	0.824	14.773	0.681			
Instructor attitude	IA1	0.905	16.831	0.821	0.871	0.909	0.770
	IA2	0.866	15.699	0.748			
	IA3	0.859	15.551	0.740			
Instructor technical competence	TC1	0.860	15.012	0.741	0.858	0.870	0.690
	TC2	0.816	13.931	0.664			
	TC3	0.816	13.961	0.666			
Content	CT1	0.901	16.592	0.810	0.884	0.893	0.737
	CT2	0.821	14.429	0.674			
	CT3	0.852	15.257	0.726			
Flow experience	FE1	0.857	15.764	0.734	0.920	0.927	0.809
	FE2	0.888	16.657	0.787			
	FE3	0.952	18.746	0.904			
Attitude towards e-learning	AE1	0.866	15.955	0.750	0.892	0.916	0.785
	AE2	0.958	18.836	0.916			
	AE3	0.831	14.972	0.691			
Learning outcomes	LO1	0.883	16.289	0.781	0.907	0.907	0.765
	LO2	0.894	16.574	0.797			
	LO3	0.847	15.264	0.717			

recommended values commonly suggested by prior literature (Chau, 1997).

Data analysis results are summarized in Fig. 2. Explanatory power of the model is fairly good. They are ranged from $R^2 = 0.357$ (dependent variable learning outcomes) to $R^2 = 0.547$ (dependent variable flow experience). Most of coefficients are significant at the 99% level.

Learner interface is found to be a positive antecedent of both flow experience (path coefficient = 0.346, $t = 4.998$) and attitude towards e-learning (path coefficient = 0.209, $t = 3.312$) at the 99% significance level. Hypotheses 1a and b are, therefore, supported. The result of Hypothesis 2a regarding the influence of interaction on flow experience is supported (path coefficient = 0.269, $t = 4.367$) at the 99% significance level. Hypothesis 2b, however, is rejected. Interaction has no significant, direct effect on attitude towards e-learning. Hypotheses 3a examining whether instructor attitude towards students (path coefficient = 0.107, $t = 1.907$) has significant positive effect on flow experience at the 99% significance level. However, its effect on attitude towards e-learning was found to be insignificant (path coefficient = 0.079, $t = 1.641$). Regarding instructor technical competence, its effect on flow experience (path coefficient = −0.030, $t = 0.066$) is insignificant, but is significant on attitude towards e-learning (path coefficient = 0.146, $t = 2.569$) at the 99% level. Hypothesis 5a, the influence of content on flow experience (path coefficient = 0.388, $t = 5.155$) and Hypothesis 5b, the influence of content on attitude towards e-learning (path coefficient = 0.262, $t = 3.785$) are both supported at the 99% significance level. Hypothesis 6 examines the impact of flow experience on attitude towards e-learning. Results show that flow experience positively effects attitude towards e-learning at the 99% significance level (path coefficient = 0.238, $t = 3.393$). Hypothesis 7a, which examines the impact of flow experience on learning outcomes was supported at the 99% significance level (path coefficient = 0.296, $t = 4.123$). Hypothesis 7b, which posited that attitude towards e-learning would influence learning outcomes was also supported at the 99% significance level (path coefficient = 0.323, $t = 3.864$). The details of direct, indirect, and total effect for each individual path are summarized in Table 6.

6. Discussions and implications

6.1. Primary findings

In this study, we presented an e-learning success model containing a flow construct and attitude as its central

Table 4
Pair-wise χ^2 test for discriminant validity

Comparing models	Fixed correlation		Freely estimated correlation			χ^2 difference
	D. F.	χ^2	*Correlation*	*D.F.*	χ^2	
LI-IT	9	418.32	0.38	8	9.65	408.67
LI-IA	9	402.21	0.13	8	23.83	378.38
LI-TC	9	334.68	0.26	8	20.07	314.61
LI-CT	9	337.94	0.47	8	19.37	318.57
LI-FE	9	317.43	0.59	8	7.45	309.98
LI-AE	9	341.00	0.56	8	13.23	327.77
LI-LO	9	378.47	0.58	8	13.74	364.73
IT-IA	9	394.12	0.22	8	8.94	385.18
IT-TC	9	314.00	0.25	8	16.64	297.36
IT-CT	9	351.37	0.30	8	7.46	343.91
IT-FE	9	380.31	0.50	8	4.19	376.12
IT-AE	9	426.44	0.36	8	18.54	407.90
IT-LO	9	409.87	0.36	8	12.05	397.82
IA-TC	9	318.40	0.17	8	6.95	311.45
IA-CT	9	359.76	0.18	8	9.04	350.72
IA-FE	9	422.46	0.26	8	27.31	395.15
IA-AE	9	387.45	0.26	8	12.90	374.55
IA-LO	9	416.59	0.22	8	40.41	376.18
TC-CT	9	366.01	0.15	8	16.56	349.45
TC-FE	9	328.12	0.19	8	17.99	310.13
TC-AE	9	312.60	0.30	8	13.64	298.96
TC-LO	9	304.62	0.41	8	14.10	290.52
CT-FE	9	292.87	0.58	8	6.04	286.83
CT-AE	9	314.91	0.56	8	34.58	280.33
CT-LO	9	342.00	0.38	8	11.69	330.31
FE-AE	9	326.08	0.62	8	14.76	311.32
FE-LO	9	352.52	0.54	8	12.13	340.39
AE-LO	9	383.44	0.51	8	29.60	353.84

Table 5
Overall fits of the research model

Goodness-of-fit measure	Recommended value	Observed value
χ^2/degree of freedom	$\leqslant$3.0	2.025 (463.89/229)
Goodness-of-fit Index (GFI)	$\geqslant$0.90	0.861
Adjusted Goodness-of-fit Index (AGFI)	$\geqslant$0.80	0.818
Non-Normed Fit Index (NNFI)	$\geqslant$0.90	0.967
Comparative Fit Index (CFI)	$\geqslant$0.90	0.973
Root Mean Square Error of Approximation (RMSEA)	$\leqslant$0.08	0.063
Root Mean Square Residual (RMSR)	$\leqslant$0.05	0.046
Standardized Root Mean Square Residual (SRMSR)	$\leqslant$0.10	0.061

Adapted from Hartwik and Barki (1994); Segars and Grover (1993).

feature. The model was empirically explored for how the two key mediation variables of flow experience and attitude, as influenced by their antecedents, affect learning outcomes in the context of ERP training with the web-based e-learning system. The advantage of incorporating these two constructs within a unitary model is that it facilitates understanding of the relative and disparate effects of various e-learning characteristics, which were derived from extant studies. Furthermore, our research framework proffers the inclusion of flow experience into a research model as a new theoretical background in the e-learning domain that might increase the understanding of learning outcomes. The results confirm that the two mediating variables (i.e., flow experience and attitude towards e-learning) have significant impact on learning outcomes in e-learning, and that the antecedent factors

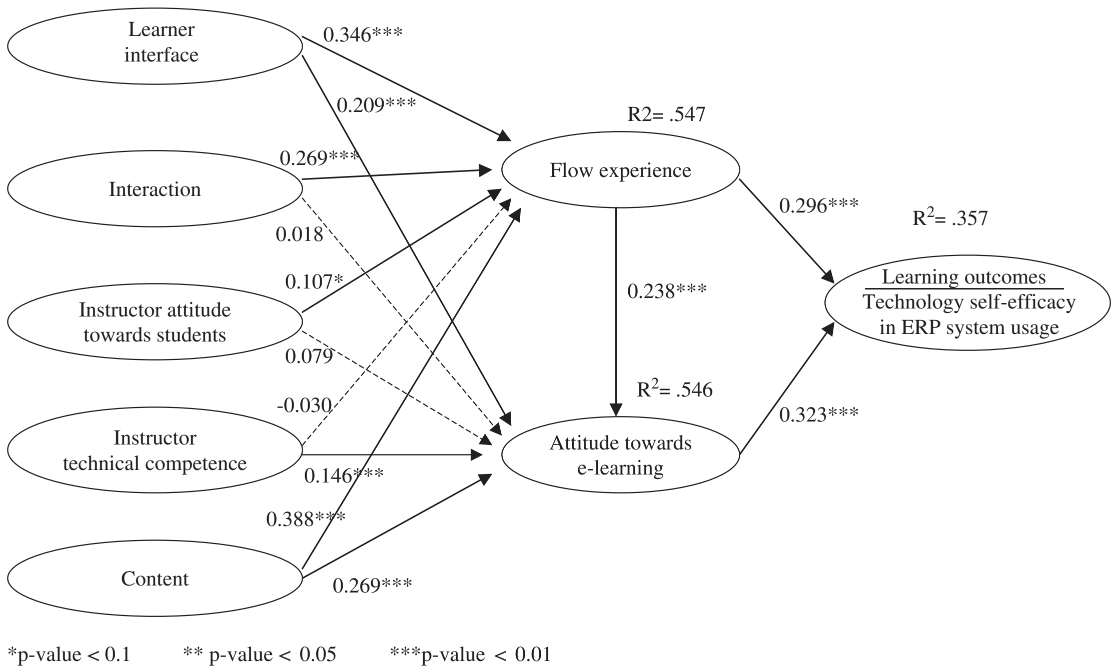

Fig. 2. Results of structural modeling analysis.

Table 6
Explanatory power of the model and strength of individual paths

	R^2	Direct effect	Indirect effect	Total effect
Effect on flow experience	0.547			
Learner interface		0.346 (4.998)	—	0.346 (4.998)
Interaction		0.269 (4.367)	—	0.269 (4.367)
Instructor attitude		0.107 (1.907)	—	0.107 (1.907)
Instructor technical competence		−0.030 (0.066)	—	−0.030 (0.066)
Content		0.388 (5.155)	—	0.388 (5.155)
Effect on attitude towards e-learning	0.546			
Learner interface		0.209 (3.312)	0.082 (2.858)	0.292 (4.777)
Interaction		0.018 (0.319)	0.064 (2.682)	0.082 (1.523)
Instructor attitude		0.079 (1.641)	0.025 (1.672)	0.105 (2.109)
Instructor technical competence		0.146 (2.569)	−0.007 (-0.446)	0.139 (2.361)
Content		0.262 (3.785)	0.092 (2.902)	0.355 (5.323)
Flow experience		0.238 (3.393)	—	0.238 (3.393)
Effect on learning outcomes	0.357			
Learner interface		—	0.197 (5.206)	0.197 (5.206)
Interaction		—	0.106 (3.307)	0.106 (3.307)
Instructor attitude		—	0.065 (2.438)	0.065 (2.438)
Instructor technical competence		—	0.036 (1.091)	0.036 (1.091)
Content		—	0.229 (5.470)	0.229 (5.470)
Flow experience		0.296 (4.123)	0.077 (2.597)	0.372 (5.677)
Attitude towards e-learning		0.323 (3.864)	—	0.323 (3.864)

t-values are specified in parenthesis; Indirect effects, total effects and their *t*-values are calculated by LISREL EF procedure.

related to flow experience could be different from those related to attitude. Thus, the results of this paper might provide a promising platform for future research on e-learning.

This research focused on investigating whether flow experience and attitude influence learning outcomes assessed by post-training technology self-efficacy in ERP system usage under the end-user training context. This study revealed that learning outcomes in an e-learning environment can be predicted by inherent variables ($R^2 = .357$). A noteworthy finding is that not only learners' attitude towards e-learning but also their flow experience determines learning outcomes, both in direct and indirect ways. To enhance the learning effectiveness with an

e-learning system, it is not sufficient to focus solely on an individual's preference for e-learning. A learner's preference for e-learning can be more enhanced if he or she can experience involvement, concentration, control, and intrinsic interest. Therefore, as is in other contexts, such as sports, shopping, and computer use, the optimal experience of flow can contribute to learning (more specifically, a student's self-perceived ability to use the ERP system after the training course in this study) in an e-learning context as well. It appears that more research is required not only on learners' attitude but also on their flow experience to improve learning outcomes in an e-learning environment.

Another important finding pertains to the mediating effects of the learner's attitude towards e-learning between flow experience and learning outcomes. The results show that a positive attitude will occupy some mediating role between flow experience and learning outcomes. It can be inferred that the efforts for improving learners' flow experience can induce learning outcomes not only in a direct way, but also in an indirect way through positive attitude or preference for e-learning with a specific system.

This study also explored and investigated whether the various e-learning factors affect the learner's attitude and flow experience simultaneously. Our result of the path analysis provides new insights into the relevant characteristics that are induced from prior literature (i.e., learner interface, interaction, instructor attitude towards students, instructor technical competence, and content). In this study, the learner interface of an e-learning system and content are revealed as important predictors of both flow experience and attitude towards e-learning. Especially, content appears to be the strongest predictor, whilst the factors regarding instructor characteristics (i.e., instructor attitude towards students, instructor technical competence) have relatively weak influence on flow experience and attitude towards e-learning. There could be two possible reasons that those factors have relatively weak impact on students' flow experience and attitude in the context of this study. The first possible reason might be that our model does not consider the characteristics of knowledge to be delivered because more competent teaching skill might be required for students to understand more complex and abstract knowledge (i.e., education) than just to understand how to use the software package (i.e., training). On the other hand, the result might stem from the unique characteristics of the e-learning context itself in which more restrictive and structured knowledge delivery occurs than in traditional face-to-face learning. If a student perceives that the content itself and the way it is structured and delivered are satisfactory enough to understand, the instructor characteristic may not make any substantial difference. The results show that the success factors that affect attitude towards e-learning do not necessarily affect flow experience, and vice versa. Interaction and instructor attitude towards students have a significant influence on flow experience, but not on attitude towards e-learning. On the contrary, instructor technical competence has a significant influence on attitude towards e-learning, but not on flow experience. This finding implies that there could be different ways to improve attitude and to reinforce flow experience. More specifically, this research contributes to the literature on e-learning, in which the impact of various e-learning characteristics on learners' attitudes are investigated; albeit not on the concept of flow. It is possible that other factors might cause flow experience, such as conducting any on-line tests or quizzes for clear goal setting, and providing immediate feedback for motivation. Further research for exploring those factors is required.

6.2. Implications for academic researchers

This study offers several contributions to the academic field. First, this study introduced the construct of flow experience from flow theory as a central part of the research model, and empirically showed the impact of flow experience on learning outcomes. Previous research gave attention to comparative analysis between the effectiveness of traditional education and that of distance learning, or to exploring critical factors that affect learner preference in e-learning. Our study showed that flow theory could be a promising theoretical foundation for the e-learning domain.

Second, we empirically validated that the relevant factors in distance learning or e-learning argued in previous research were critical for enhancing both learner attitude towards e-learning and flow experience. Finding antecedents of those two key constructs and exploring the structural relationship between them is another academic contribution of this work. One interesting finding is that the factors regarding instructor characteristics do not affect, or have relatively weak influence on student attitude and flow experience in the context of our study, that is drill and practice type end-user training. However, this result must be interpreted cautiously because it is not in accordance with Webster and Hackley's (1997) distance learning work where instructor characteristics have important influence both on students' cognitive engagement and on attitudes towards using a specific technology for distance learning. Intuitively, one might expect that learners would have a positive attitude and flow experience if they found the instructor competent in his or her teaching manner/attitude and the instructor had the ability to use and promote the related technology effectively. However, at least under the context of drill and practice application package usage training with an e-learning system, it is possible for learners to be less affected by instructor characteristics. This means that the importance of the instructor's role can vary according to the nature of the learning context and the learning tasks to which an e-learning system is applied. For instance, instructor characteristics can be more important under education for abstract theory and/or scenario/project based learning task environments rather than under end-user training for

information system usage and/or drill and practice types of learning environments. Future research should focus on the influence of instructor characteristics under a number of different types of e-learning environments.

Third, flow experience has a significant effect on learning outcomes both in a direct way and in an indirect way via attitude towards e-learning. This result is in accordance with previous research on computer usage based on flow theory, in which flow is incorporated as a motivator of individual behavior. One notable aspect of the result is the significant relationship between flow experience and attitude; each of them is a key construct in flow theory and TRA, respectively. Whilst TRA is based on the assumption of an individual's rationality in evaluating and analyzing external stimuli, flow theory is focused more on an individual's affective and holistic experience in explaining human behavior and its results. Moreover, flow theory can be useful for understanding even some non-beneficial or addictive human behavior that is difficult to explain with only the perspective of TRA. Thus, this study can be considered as an attempt to combine the perspective of flow theory and that of TRA for a more comprehensive e-learning success model.

Finally, we empirically validated that factors that have an influence on flow experience, can have no significant influence on learner attitude towards e-learning (e.g., interaction and instructor attitude towards e-learning). This result infers that there could be a different set of factors affecting flow experience and learner attitude towards e-learning. If so, isolating the dynamics between those factors—attitude and flow experience—can be a critical research question for gaining a better understanding of the resulting e-learning outcomes.

We invite other researchers to refine this model in various e-learning contexts and validate our findings. We also expect different perspectives regarding the application of our research model.

6.3. Implications for e-learning practitioners

The immediate beneficiaries of the findings of this study may be the group of people who are responsible for managing and improving curriculum with e-learning systems (managers in educational institution or in business organization in which employees are trained with an e-learning system). For implementing successful e-learning courses by improving learning outcomes, these people can derive specific interventions from the findings of this study. They can:

(1) Make an effort to simultaneously manage learners' attitude towards e-learning and flow experience. Nowadays, educational institutions and business organizations are investing various resources into e-learning systems for acquiring innovative education effects. However, without any effort to induce learners' flow experience, it will be difficult to achieve high effectiveness in e-learning. The reason is that some aspects of e-learning (i.e., interaction and instructor attitude towards students) have an impact on the learner's flow experience rather than his/her preference for e-learning. In order to improve an individual's flow experience, it is necessary to give attention to what leads to flow in computer-mediated environments, such as easy-to-use artefact, clear task goals and methods for giving adequate feedback to students (see Finneran and Zhang, 2003).
(2) Check if the e-learning system shows enough technological quality from the perspective of e-learners. Nowadays an e-learning system can be seen as a kind of web-based information system, thus, learners can be seen as end users of those systems. Therefore, ongoing improvement of the web-based systems and maintenance for easy system interface, stability in content delivery, easy-to-load and reliable solutions, and satisfactory download speed are required.
(3) Plan and operate a diverse set of interactive communication channels for learners to experience total engagement in the virtual classroom. For direct and timely feedback, interaction not only with instructors but also with other students should be supported with the interactive channels.
(4) Provide learners with high quality content that can be evaluated as beneficial and customized for them. Whilst the functionality of the e-learning system is important, one should not neglect the fact that "what" to deliver is more important than "how" to deliver it. It means that the most important element in education is which content is offered to learners. Content, thus, should be up-to-date and tailored to fit to learners' needs.

For the e-learning providers, it may be critical to understand the dynamics amongst e-learners' flow experience, their attitude towards e-learning, and learning outcomes. In addition, they may also need to establish a set of criteria to evaluate the quality of e-learning courses from the perspective of e-learners for their resource allocation decisions.

7. Conclusions and limitations

With the advent of the Internet, e-learning is gaining popularity and educational institutions and firms are increasingly introducing new e-learning courses. We presented an e-learning success model based on flow theory and empirically validated it with the data collected from an information system training project—an ERP training program with a web-based e-learning system. This effort can be helpful as a research foundation for future e-learning research, especially for system usage training with interactive e-learning systems. However, there are some research limitations that should be overcome in future research.

First, there are necessities for more strategic sampling and data gathering methods with a more diversified sample. This study is based on self-reported data and cross-sectional design. In addition, the sample is only composed of students in vocational high school in Korea and the response rate is relatively low (about 25%). Those characteristics could cause some non-response bias and limitations in externalizing the results of this study.

Second, the assessment of learning outcomes was limited to perceptual data. Although each student's technology self-efficacy is one of the primary purposes of the ERP training course, and used in other studies as a measure of learning outcomes, the actual grades and test performance in the course taken can be more objective to assess learning outcomes.

Finally, we believe that an extended model with a wider set of antecedent factors, which were not dealt with in this study, and research within various e-learning contexts, will contribute to the maturity of e-learning knowledge. According to the context to which e-learning is applied, the relative importance of each antecedent can vary. For example, though the importance of the factors regarding instructor characteristics is relatively low in the end user training course, the result can be different in other e-learning courses that deal with more abstract and theoretical subjects. Further, the degree of fit between the subject to learn and the e-learning system and/or individual factors can be explored based on prior flow studies in computer-mediated environments (e.g., Finneran and Zhang, 2003; Finneran and Zhang, 2005).

Appendix A. Measures

Please circle a number from the scale 1 (disagree strongly) to 5 (agree strongly) below that most closely corresponds with how you perceive training with the ERP package with the e-learning system.

(a) *Learner interface*:
- (LI1) The e-learning system was easy to use.
- (LI2) The e-learning system was user-friendly.
- (LI3) The content provided by the e-learning system was easy to understand.

(b) *Interaction*:
- (ITR1) I could interact with other students though the e-learning system.
- (ITR2) I could easily contact the instructor through the e-learning system.
- (ITR3) The e-learning system gave me direct/timely feedback.

(c) *Instructor attitude towards students*:
- (IA1) The instructor was friendly towards individual students.
- (IA2) The instructor had a genuine interest in students.
- (IA3) Students felt welcome in seeking advice/help.

(d) *Instructor technical competence*:
- (IC1) The instructor explained well how to use the ERP training system.
- (IC2) The instructor was keen that we were following the ERP training.
- (IC3) The instructor handled the ERP technology effectively.

(e) *Content*:
- (C1) The e-learning system provided up-to-date content.
- (C2) The e-learning system provided content that exactly fits your needs.
- (C3) The e-learning system provided useful content.

(f) *Attitude towards e-learning*:
- (AT1) Using the e-learning system for ERP training is a wise idea.
- (AT2) I like the idea of using the e-learning system for ERP training.
- (AT3) Using the e-learning system for ERP training is pleasant.

(g) *Flow experience*:

Instructions: The word "flow" is used to describe a state of mind sometimes experienced by people who are totally involved in some activity. One example of flow is the case where a learner is extremely concentrated on ERP training and achieves a state of mind where nothing else matter but the class; the learner engages in training ERP with total involvement and intrinsic interests. This might be regarded as being completely and deeply immersed in it
- (FE1) Do you think you have ever experienced flow in taking ERP training with the e-learning system?
- (FE2) In general, how frequently would you say you have experienced "flow" when you take ERP training with the e-learning system?
- (FE3) Most of the time I take ERP training with the e-learning system I feel that I am in flow.

(h) *Learning outcomes* (*Technology self-efficacy in ERP system usage*):
- (LO1) I have mastered how to use the ERP system.
- (LO2) I am certain I can use the ERP system well.
- (LO3) I believe that I will be able to use the ERP system easily in the future.

Appendix B. Conceptual definitions, items, and sources

See Table A1

Appendix C. Correlation matrix of measurement items and descriptive statistics ($N = 223$)

See Table A2

Table A1

Construct	Conceptual definition	Measures		Mean	SD	Skewness	Kurtosis	Sources
Learner interface	Student's perception on the ease of use of the e-learning system	LI1	System is easy to use	3.30	.92	.084	−744	Wang (2003) with modification
		LI2	System is user-friendly	3.30	.95	.120	−.837	
		LI3	System provides easy-to-understand content	3.31	.90	.073	−.685	
Interaction	Interactive abilities of the e-learning system amongst students, the instructor, and learning community	IT1	Interaction with other students	3.92	.84	−.693	.521	Volery and Lord (2000) with modification
		IT2	Contact with instructor	3.75	.87	−.535	.088	
		IT3	Direct/ timely feedback	3.54	.91	.013	−.518	
Instructor attitude towards students	Instructor's personal approach and teaching manner	IA1	Friendliness towards students	3.76	.87	−.434	−.044	Volery and Lord (2000) with modification
		IA2	Genuine interest in students	3.65	.83	−.189	−.093	
		IA3	Advice and help	3.86	.91	−.712	.153	
Instructor technical competence	Instructor's ability to use and promote the related technology effectively	TC1	Skills to explain how to use the related system	3.29	.81	−.096	−.737	Volery and Lord (2000) with modification
		TC2	Care for students following up the ERP training	3.60	.86	−.204	−.581	
		TC3	Skills to handle the related system	3.41	.81	.163	−.433	
Content	Student's evaluation on the usefulness of the content provided by the e-learning system	CT1	Content is up-to-date	3.59	.77	−.378	.371	Wang (2003) with modification
		CT2	Content fits learner's needs	3.35	.78	.075	.146	
		CT3	Content is useful	3.56	.76	−.356	.374	
Attitude towards e-learning	Student's evaluative feelings about using the specific e-learning system for ERP training	AT1	Using the e-learning system is a wise idea	3.71	.79	−.387	−.166	Taylor and Todd (1995) with modification
		AT2	I like the idea of using the e-learning system	3.57	.77	−.084	−.353	
		AT3	Using the e-learning system is pleasant	3.46	.79	.072	−.408	
Flow experience	The holistic sensation that people feel when they act with total involvement	FE1	Experience of flow	3.43	.94	.165	−.860	Novak et al. (2000) with modification
		FE2	Frequency of flow	3.25	.95	.303	−.702	
		FE3	Intensity of flow	3.18	.96	.106	−.582	
Technology self-efficacy in ERP system usage	Student's self-perceived ability to use the ERP system after the training course	LO1	Mastered the use of ERP	3.22	.80	.435	−.094	Hollenbeck and Brief (1987) with modification
		LO2	Confidence to use ERP well	3.04	.88	.444	−.593	
		LO3	Ability to use ERP easily	3.32	.93	.048	−.931	

Table A2

Items	LI1	LI2	LI3	IT1	IT2	IT3	IA1	IA2	IA3	TC1	TC2	TC3	CT1	CT2	CT3	FE1	FE2	FE3	AT1	AT2	AT3	LO1	LO2	LO3
LI1	1.000																							
LI2	.777	1.000																						
LI3	.725	.764	1.000																					
IT1	.294	.313	.352	1.000																				
IT2	.229	.274	.327	.845	1.000																			
IT3	.251	.274	.347	.767	.745	1.000																		
IA1	.070*	.058*	.064*	.164	.192	.154	1.000																	
IA2	.173	.086*	.148	.216	.245	.221	.781	1.000																
IA3	.167	.119	.069*	.115	.173	.113	.785	.739	1.000															
TC1	.142	.142	.267	.232	.233	.235	.054	.103	.095	1.000														
TC2	.130	.086	.213	.169	.106	.114	.131	.137	.165	.703	1.000													
TC3	.230	.232	.306	.182	.206	.140	.144	.139	.177	.693	.676	1.000												
CT1	.382	.412	.371	.252	.261	.266	.103	.119	.121	.106	.066	.125	1.000											
CT2	.322	.423	.374	.225	.241	.277	.106	.138	.077	.146	.111	.222	.726	1.000										
CT3	.294	.294	.245	.208	.194	.195	.186	.189	.193	.073	.119	.110	.781	.694	1.000									
FE1	.407	.432	.438	.368	.368	.349	.125	.199	.174	.131	.111	.176	.461	.469	.402	1.000								
FE2	.417	.429	.474	.427	.407	.424	.274	.328	.276	.148	.229	.210	.458	.455	.410	.766	1.000							
FE3	.470	.506	.537	.443	.424	.428	.176	.247	.149	.117	.122	.142	.504	.485	.428	.816	.842	1.000						
AE1	.450	.476	.439	.334	.334	.299	.181	.279	.190	.294	.250	.249	.495	.522	.442	.471	.492	.553	1.000					
AE2	.448	.486	.443	.309	.300	.287	.192	.295	.208	.264	.217	.243	.434	.530	.421	.521	.524	.558	.833	1.000				
AE3	.431	.474	.473	.348	.374	.362	.136	.258	.130	.237	.126	.230	.445	.519	.388	.463	.513	.520	.672	.805	1.000			
LO1	.426	.442	.519	.305	.316	.376	.197	.247	.121	.323	.259	.272	.275	.363	.260	.408	.453	.492	.406	.349	.351	1.000		
LO2	.393	.427	.520	.246	.254	.323	.060	.194	.118	.316	.233	.293	.299	.374	.274	.418	.439	.469	.480	.432	.453	.792	1.000	
LO3	.392	.396	.477	.251	.285	.304	.183	.291	.215	.356	.300	.388	.280	.299	.232	.289	.376	.371	.516	.446	.432	.744	.758	1.000
Mean	3.30	3.30	3.31	3.92	3.75	3.54	3.76	3.65	3.86	3.29	3.60	3.41	3.59	3.35	3.56	3.43	3.25	3.18	3.71	3.57	3.46	3.22	3.04	3.32
SD	.92	.95	.90	.84	.87	.91	.87	.83	.91	.81	.86	.81	.77	.78	.76	.94	.95	.96	.79	.77	.79	.80	.88	.93

All correlations without asterisk are significant at 95% significance level.Asterisked correlations are significant at 90% significance level.

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